EPSON AMERICA, INC.
OEM PRODUCTS DIVISION

SD-560 FLEXIBLE DISK DRIVE SPECIFICATIONS

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REVISION #1

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1. Scope

These specifications apply to the SD-560 double-sided, double-track, high-density, 5.25-inch flexible disk drive.

2. Outline

The SD-560 flexible drive is suitable for use as external memory service with personal computers, word processors, etc. and features the following.

(1) Very thin cabinet of 41 mm, 1.6 in., half height of conventional disk drive cabinet.

(2) The head positioning mechanism uses a stepper motor and steel band to achieve an access time of 3 msec.

(3) Most of the control circuit and read amplifier is incorporated in two LSI chips, reducing size of the printed circuit board and improving reliability.

(4) Use of high density recording medium makes it possible to obtain a recording format compatible to that of an 8" standard flexible disk.

(5) The flexible disk ejector, actuated by a push button, makes it easy to remove the disk.

(6) Maintenance-free DC brushless direct drive spindle motor provides high reliability.

(7) The head load mechanism uses a specially designed rotary solenoid to improve read/write reliability and reduce power consumption.

3. General specifications

3.1 Storage capacity:

(1) Unformatted: 802K bytes (single density)
1604K bytes (double density)
(2) Formatted: 513K bytes (single density)
(26 sectors/ track) 1025K bytes (double density)

3.2 Recording density (side 1, track 76):

4823 BPI (single density)
9646 BPI (double density)

3.3 Transfer rate

250K bits/sec (single density)
500K bits/sec (double density)

3.4 Average rotational delay

83 msec.

3.5 Access time

(1) Track to track: 3 msec.

(2) Average access time: 93 msec.

(3) Settling time: 15 msec.

3.6 Head load time

35 msec.

3.7 Track density

96 TPI

3.8 Number of tracks

154

3.9 Radius of innermost track

Track 76, side 0: 37.05 mm
Track 76, side 1: 34.93 mm

3.10 Radius of outermost track

Track 0, side 0: 57.15 mm
Track 0, side 1: 55.03 mm

3.11 Recording method

FM, MFM

3.12 R/W head

(1) Type: Tunnel erase type read/write head with gimbal support

(2) Positioning system: Stepper motor

3.13 Spindle motor

Direct drive spindle motor

Start-up time: 1.0 sec
Speed: 360 rpm

3.14 Detectors

(1) Index hole sensor: Photoelectric converter

(2) Track 00 sensor: Photoelectric converter

(3) Write protect status sensor: Photoelectric converter

3.15 Operating conditions

(1) Temperature: 4 to 43°C (within the range specified for media used)

(2) Humidity: 20 to 80% (no condensation)

(3) Maximum wet-bulb temperature: 29°C

(4) Vibration: 5 to 60Hz, 0.6 G or less

3.16 Transportation and storage conditions

(1) Temperature: −40°C to 65°C (transportation)
−20°C to 65°C (storage)

(2) Humidity: 95% or less

(3) Vibration: 5 to 60 Hz, 3 G or less

(4) Impact: 50 G or less

3.17 Power supply

(1) +12V (±5%)

Read current: 0.4A (typ.)
1.5 A (max.) (motor start-up time period: 500 msec max.)

Permissible ripple: 250 mVpp max.

(2) +5V (±5%)

Read current: 0.45A (typ.)
0.72A (max.)

Permissible ripple: 100 mVpp (max.)

(3) Start-up time: 100 msec (max.) (12V and 5V)

3.18 Power dissipation (during operation)

7.1 W (typ.)

3.19 Dimensions (without panel)

(1) Width: 146 mm (5.7 in.)

(2) Depth: 195.5 mm (7.7 in.)

(3) Height: 41 mm (1.6 in.)

3.20 Weight

1.4 kg (3.08 lbs)

3.21 Orientation

3 ways (See Section 4.5)

3.22 Installation

Using screws on the sides and bottom

3.23 Reliability

(1) MTBF: 10,000 hours (POH)

(2) MTTR: 30 minutes

(3) Design Life: 5 years

(4) Software error rate: 10^{-9} or better

(5) Hardware error rate: 10^{-12} or better

(6) Seek error rate: 10^{-6} or better

(7) Disk life: $.3 \times 10^{6}$ passes per track

3.24 Connector

(1) Power connector: AMP P/N 1-480424-0 or equivalent

(2) Signal connector: 3M P/N 3463- 0001 or equivalent

3.25 Medium

130 mm (5.25 in.) flexible disk approved by both Epson and user.

3.26 Front panel material

ABS resin (black)

3.27 Safety

Comply with UL standards

4. Detailed Specifications

4.1 Fundamental operation

The SD-560 5.25-inch flexible disk drive consists of four functional blocks: the read/write block, the control block, the spindle motor circuit block, and the head positioning mechanism control block.

These blocks perform the following functions:

(1) Reads and writes data.

(2) Controls the operation of disk drive according to control signals.

(3) Controls spindle motor speed.

(4) Moves heads to the specified position.

4.2 Read/write circuit and components

4.2.1 Read/write heads

The read/write heads are tunnel erase type ferrite heads having a high reliability. Each head is supported by a gimbal which provides optimum head touch condition, thus minimizing any damage to disk surface when head is loaded or unloaded.

4.2.2 Index sensor

The index sensor uses a photodiode and phototransistor pair to detect the index hole.

4.2.3 Head positioning mechanism

The head positioning mechanism uses a stepper motor and a

steel band to position the heads.

The host system must specify the direction of head movement and send a step pulse per track to move the heads.

4.2.4 Head load mechanism

The head load mechanism uses a bistable rotary solenoid which features low power consumption.

4.2.5 Disk drive mechanism

The direct drive spindle motor rotates at 360 rpm. The motor speed is regulated by feeding back the speed signal generated by the FG coil built into the motor.

4.2.6 Disk protection mechanism

The button lock mechanism prevents the collet mechanism from lowering when disk is not completely inserted into the drive.

4.2.7 Write protect status sensor

The write protect status sensor uses a photodiode and phototransistor pair to detect the write protect notch on the disk jacket. The control block inhibits write operation when the sensor cannot detect the notch (that is, when a jacket with a protection tab is inserted in the drive).

4.2.8 Disk eject mechanism

The disk is fixed to spindle pulley when the button on the front panel is depressed.

The disk is automatically ejected when the button is depressed again.

The disk can be ejected when the head is loaded. To eject disk immediately after it is inserted, press button by 4-5 mm and release it.

4.2.9 Control circuit

The control circuit is on the main PCB and drive motor PCB. The control circuit consists of:

(1) Read/write logic and amplifier

(2) Stepper motor control circuit

(3) Track 00 detector

(4) Head load solenoid drive circuit

(5) Index detection circuit

(6) Side select circuit

(7) Write protect status sensor circuit

(8) Spindle motor control circuit

Most of the above circuits are controlled by a 4-bit CPU.

4.3 Interfacing

Up to 4 SD-560 flexible disk drives can be connected to a host system with the daisy chain configuration. +12V and +5V are required for interfacing.

4.3.1 Input or output signal specifications

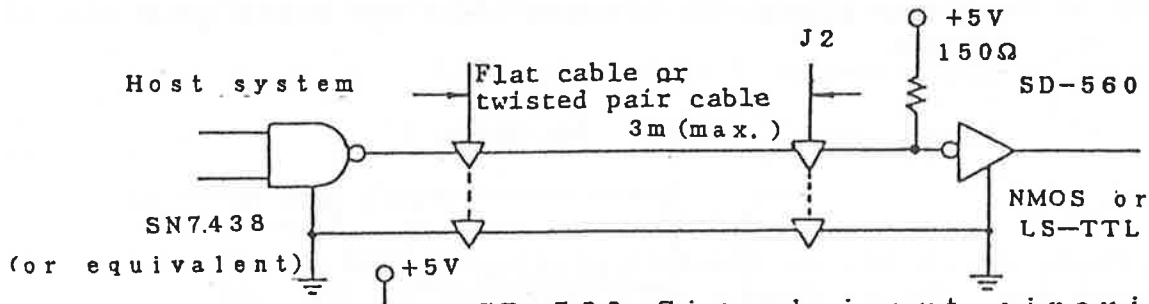
"Low" = True V_{IN}: 0 to +0.4V I_{IN}: 40mA (max.)

"High" =False V_{IN}: +2.5 to +5.25V

I_{IN}: 0 mA (open)

The SD-560 uses SN7438 for output.

Each output terminal is pulled up to +5V via a 150 ohm resistor.



SD-560 Signal input circuit

SD-560 Signal output circuit.

4.3.2 Functions of input signals

(1) Drive select 0 to 3 (DS0 - DS3)

These signals select the drive address to be used. The address of each drive is determined by the settings of the jumpers (connector SS1) on the main PCB. The drive can receive and send signals when the select signal, determined by the jumpers, is received.

(2) Motor ON (MON)

The spindle motor starts rotating when the MON signal drops to LOW.

Read or write operation should be started after the RDY signal drops to LOW.

The RDY signal drops to LOW 1 sec. (max.) after the MON signal has dropped.

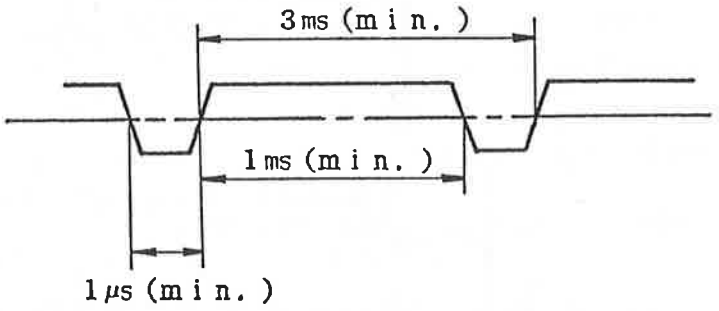
(3) Direction (DRTN)

The DRTN signal determines the direction of the stepper motor which positions the read/write heads. The heads move inward when the DRTN signal is LOW, and vice versa.

(4) Step (STP)

Pulse signal which moves the heads. They are moved one step in the direction determined by the DRTN signal, each time the STP signal drops to LOW. The period of STP pulses should be 3 msec. or more.

The STP signal is ignored when the write gate signal is LOW.



(5) Write gate (WTG)

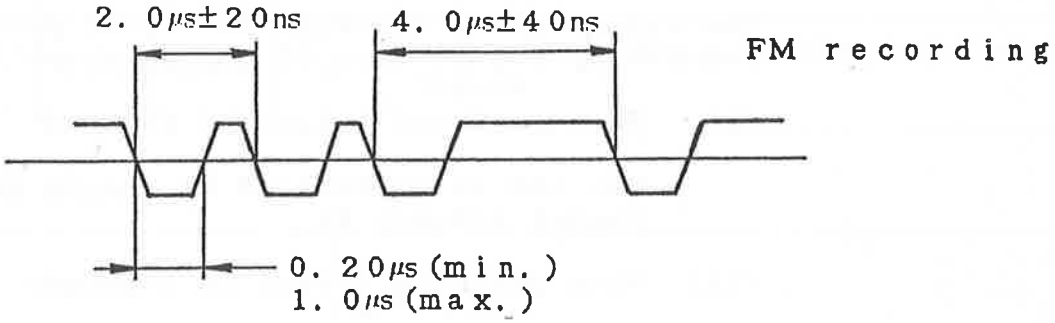
Write data is valid when the WTG signal is LOW: otherwise, read data is valid.

Writes to a disk, on which the write protect label is attached, is inhibited.

(6) Write data (WTC)

This signal allows data to be written to the flexible disk. The read/write head current is reversed when the level of this signal changes from HIGH to LOW.

This signal is valid when the WTG signal is LOW



(7) Side select (SSL)

This signal selects the read/write head to be used.

LOW 0: side 1 (upper head)

HIGH 1: side 0 (lower head)

(8) In use (IUL)

This signal controls the LED on the front panel. The LED is lit when this signal is LOW, and vice versa.

This signal is not valid when SS2 remains factory set.

4.3.3 Optional functions

The following optional functions can be used by changing the settings of switches on the main PCB.

(1) MX (position 5 of SS1)

The drive can be placed always in the selected state by shorting position MX of SS1. This option is effective for a system with one disk drive.

At this time, the drive select signal can be used for controlling the LED. (Position DSO is shorted at the time of shipping from the factory.)

(2) IU, ID (positions 1, 2 and 3 of SS2)

The signal which controls the front panel LED can be changed by the setting of SS2 as shown below.

(i) When position 1 (IU) is shorted

The LED is controlled by the in use (IUL) signal (J2-pin 4).

(ii) When position 2 (ID) is shorted

The LED is controlled by the drive select signal.

(iii) When positions 1 (IU) and 3 (ID) are shorted

The LED lights only when both the in use and drive select signals are active.

(Position 2 (ID) is shorted at the time of shipment from the factory.)

(3) MS, HS (positions 4 and 5 of SS2)

The signal which controls the head load solenoid can be changed as follows.

(i) When position 4 (MS) is shorted

The head is loaded by the motor on signal.

(ii) When position 5 (HS) is shorted

The head is loaded by the drive select signal.

(Position 5 (HS) is shorted at the time of shipment from the factory.)

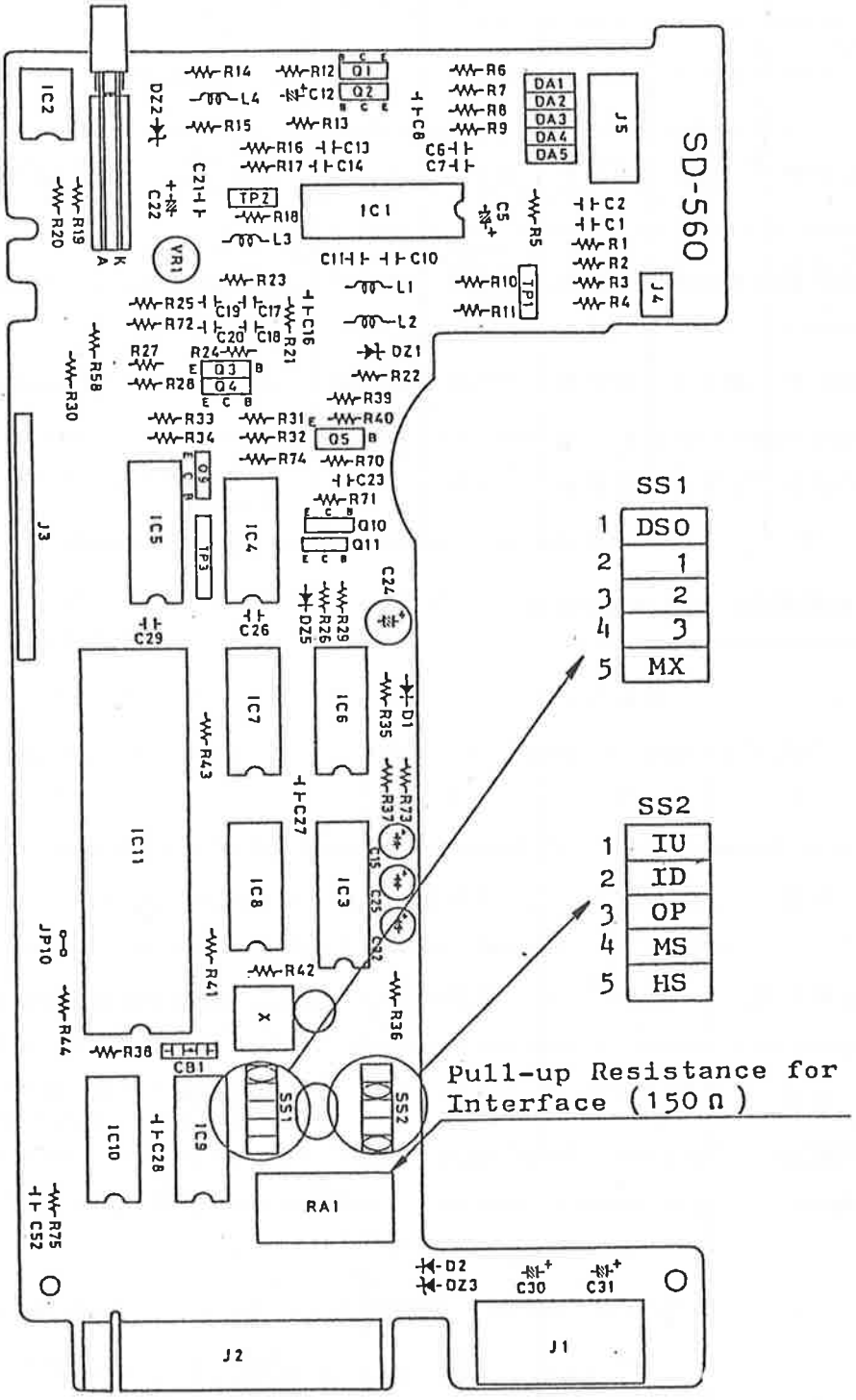
Switch selection list * POSITIONS USED
Positions 1 to 5 of SS1

1	2	3	4	5	
* ON	OFF	OFF	OFF	OFF	Selected by Drive Select 0.
OFF	ON	OFF	OFF	OFF	Selected by Drive Select 1.
OFF	OFF	ON	OFF	OFF	Selected by Drive Select 2.
OFF	OFF	OFF	ON	OFF	Selected by Drive Select 3.
OFF	OFF	OFF	OFF	* ON	Selected regardless of the Drive Select Signals.

Position 1 to 5 of SS2

SS2			LED control
1	2	3	
ON	OFF	OFF	LED controlled by the In Use signal.
OFF	ON *	OFF	LED controlled by the Drive Select signal.
ON	OFF	ON	LED lit only when both the In Use and Drive Select signals are active.

	SS2		Head load control
	4	5	SEE LAST SECTION PAGE 10
HS	OFF	ON	Head is loaded by the Drive Select signals (DS0 - 3).
MS	ON	OFF	Head is loaded by the MON signal.



Main PCB appearance (component side)

4.3.4 Output signals

(1) Ready (RDY)

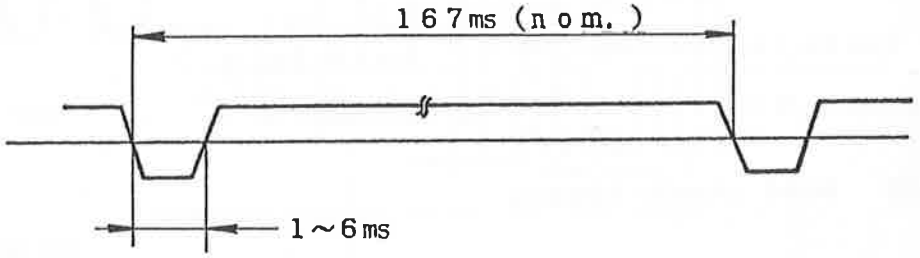
The RDY signal drops to LOW after a disk has been inserted in the drive and has begun rotating normally. The SD-560 includes a detection circuit which uses the Index signal to determine whether a disk is loaded and RDY signal control is functioning.

(2) Track 00 (TK00)

The TK00 signal drops to LOW when the read/write head is positioned to track 00, the outermost track on the disk. With the SD-560, the read/write head is automatically returned to track 00 after the power is turned on. Within one second after the power is turned on, the head returns to track 00, and the unit becomes ready to accept control signals after the Track 00 signal has been made active.

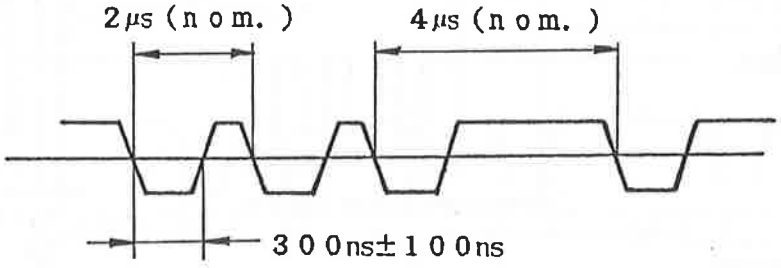
(3) Index (IDX)

One LOW pulse is output by this signal each time the disk makes one revolution. The falling edge of this pulse indicates the beginning of the track. (When using hard sector type disks, pulses are output for each index hole.)



(4) Read data (RDD)

The RDD signal outputs the series of raw data pulses read by the read circuit. This signal is normally HIGH, dropping to LOW whenever a magnetic reversal is encountered on the disk.



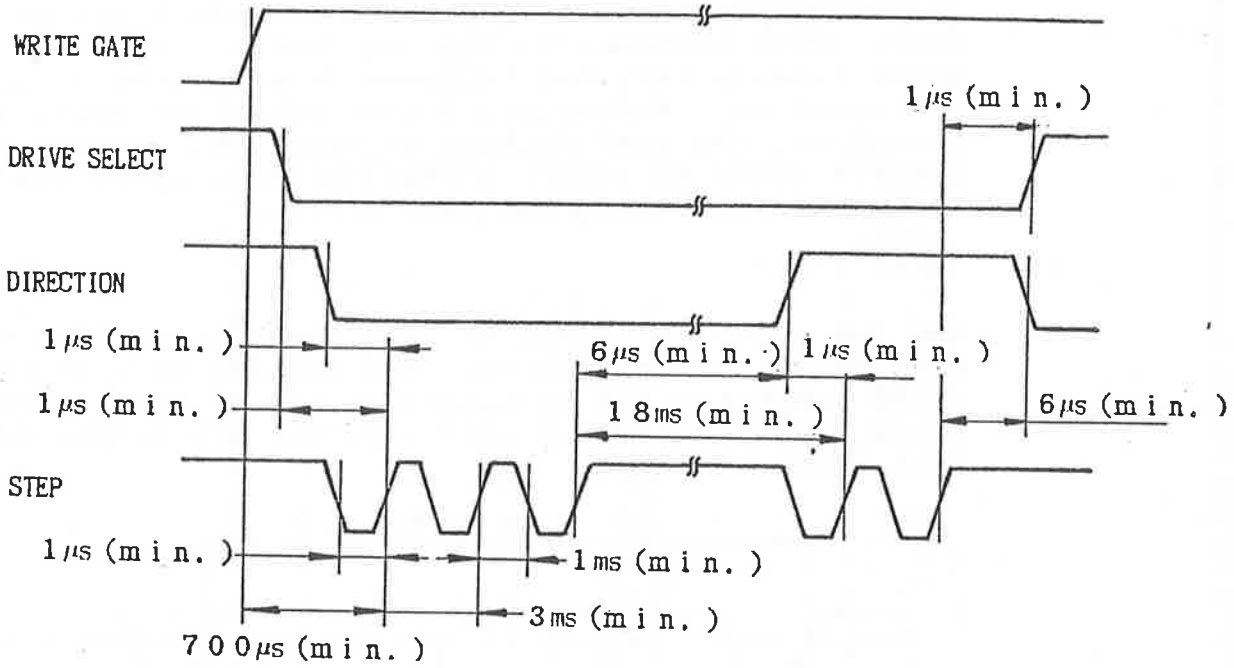
(5) Write Protect (WPT)

The WPT signal becomes LOW and is sent to the host when a write protect label is affixed to the disk inserted in the drive.

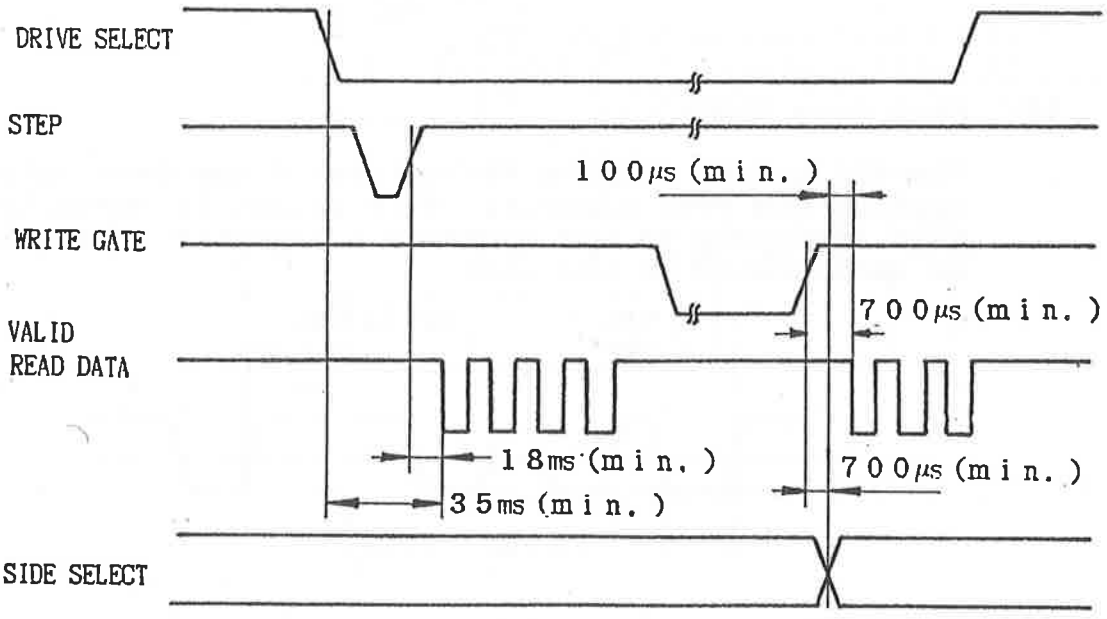
4.3.5 Timing

The following charts show signal timings when the head loading Drive Select signal option has been selected.

(1) Track seek timing

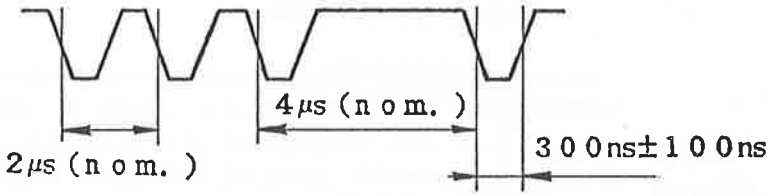


(2) Read start timing

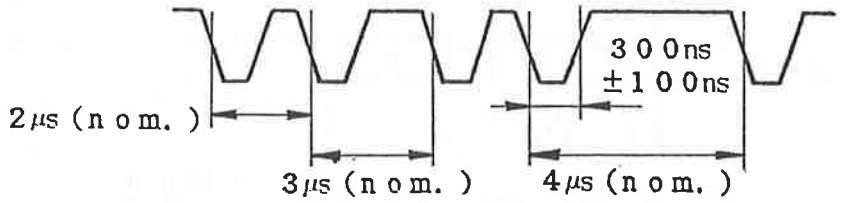


(3) Read data timing

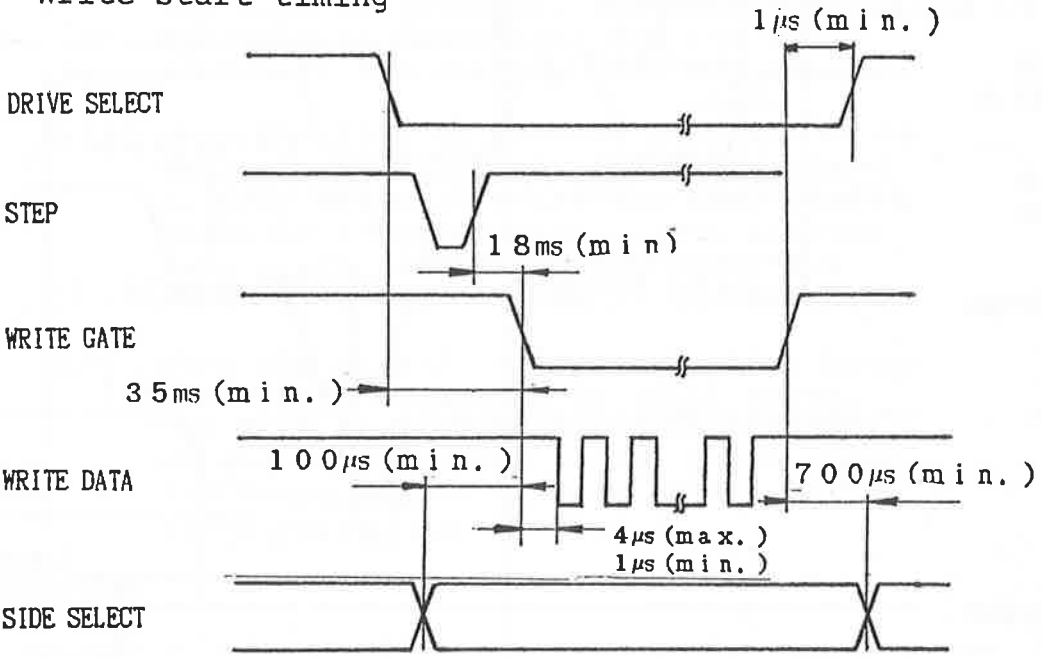
With FM method



With MFM method

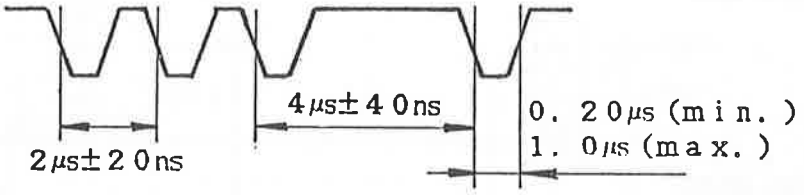


(4) Write start timing

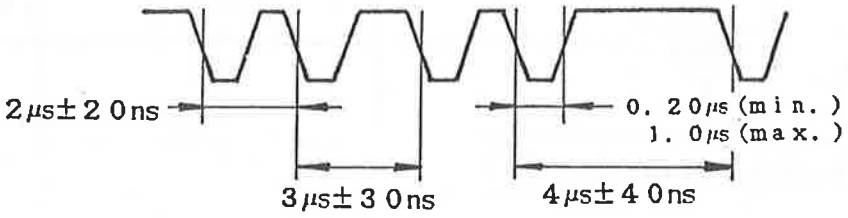


(5) Write data timing

With FM method

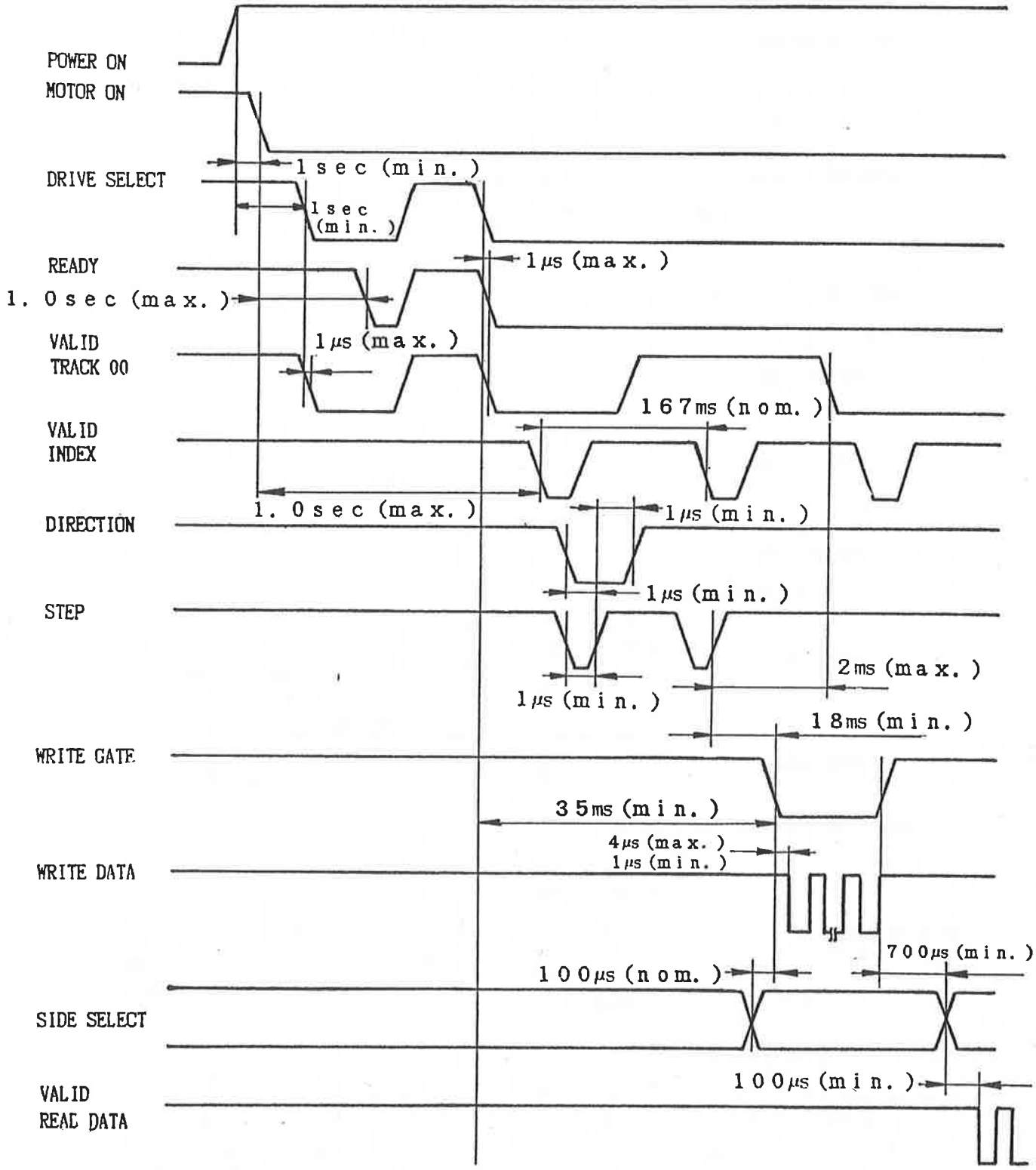


With FM method



(6) Control data timing

The following charts show signal timings when the head loading Drive Select signal option has been selected. Track 00 is assumed to be at the initial head position.



(7) Head Loading Timing and Ready Signal

In the SD-560, the Ready signal and actual actuation of the solenoids is controlled by the Motor On signal and Index signal pulses generated during disk rotation. The Ready signal informs the host as to whether or not a disk is loaded and is normally rotating.

(i) After the Motor On and Head Load signals go ON, when a disk is inserted, the head loading solenoid is actuated on the second Index signal pulse, then the Ready signal goes active on the fifth pulse. However, the head loading solenoid is actuated immediately when the Head Load signal goes ON after the Ready signal is made active by the Motor On signal going on.

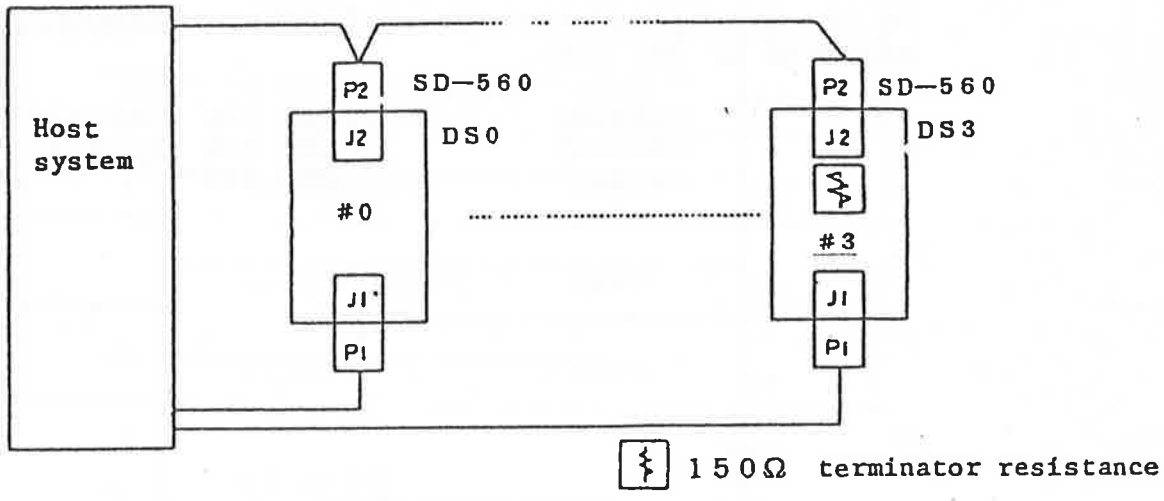
(ii) When the Motor On signal goes OFF while the disk is rotating, the head loading solenoid is deactuated and the Ready signal is immediately made non-active.

(iii) When the disk is removed from the drive while it is rotating, the Ready signal is made non-active and the head loading solenoid is deactuated. Both actions take place simultaneously about 0.6 seconds after the disk is removed.

(iv) When the disk is reinserted after being removed as described in (iii) above, the head loading solenoid is actuated on the second Index signal pulse, then the Ready signal is made active on the fifth pulse.

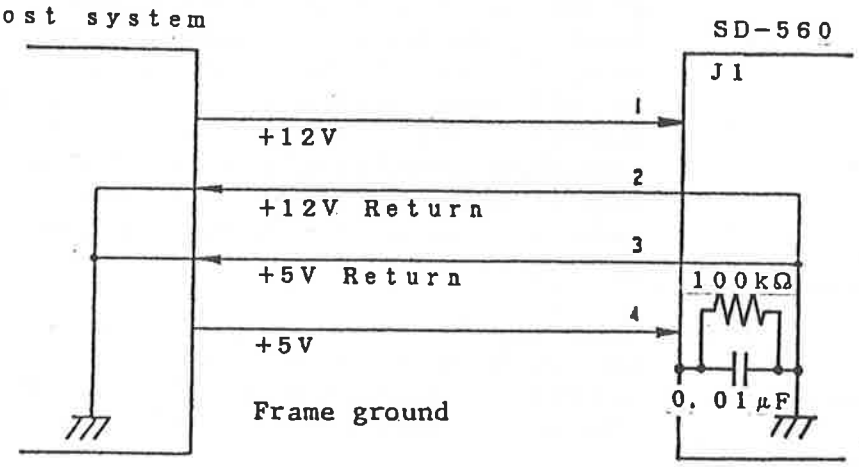
4.4 Connection

The SD-560 is connected to the host system through two types of connectors. The power lines are P1 and J1, and the signal lines are P2 and J2.

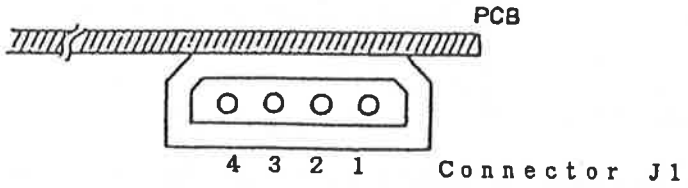


When two or more SD-560s are connected in a daisy chain configuration, the terminator resistance is included in only on of the drives.

4.4.1 Power Connector



DC power supply connector J1 is installed on the main PC board, and consists of a 4-pin A M P connector (P/N 1-480426-0).



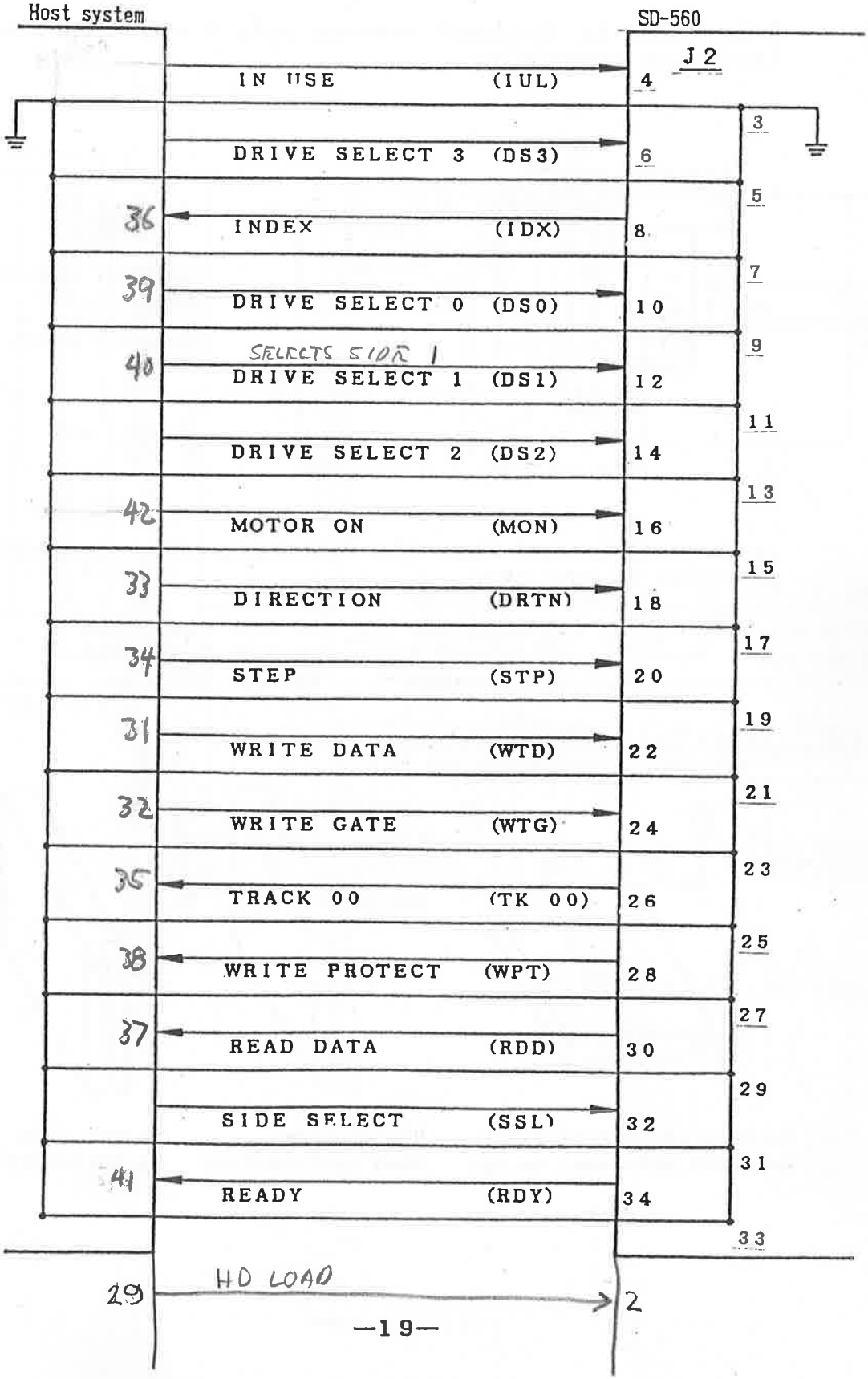
It is recommended that the following connector parts be provided by the user.

Housing	APM P/N 1-480424-0
Contact	APM P/N 60619-1
Cable	AWG #18

4.4.2 Signal connectors

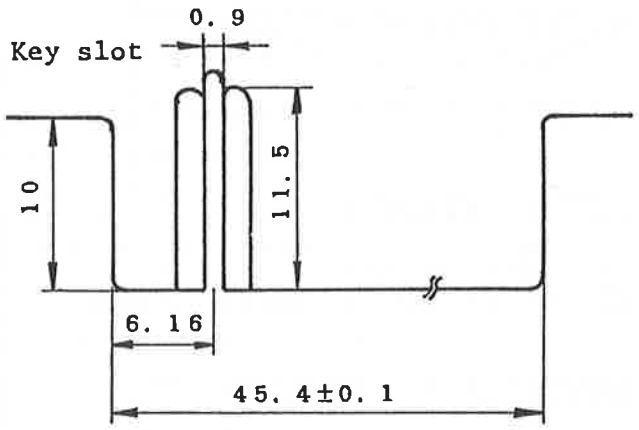
Up to four SD-560 mini-floppy disk drives can be connected in a daisy chain configuration. All signal inputs and outputs are TTL-compatible. The power supply interface required +12V and +5V.

Signal interface (main PC Board connector J2)



A 34-pin card edge connector is used for connector J2. The pins of this connector are numbered 1 to 34; pins on the component side of the board are even-numbered, and those on the soldered side are odd-numbered. Dimensions of this connector are shown below.

A key slot is included between pins 4 and 6 to prevent incorrect connection.



Connector contact width: 1.27

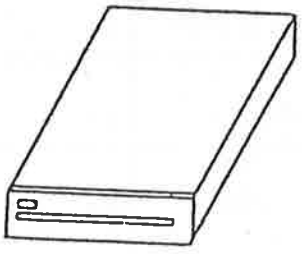
Connector pitch: 2.54

(Unit: mm)

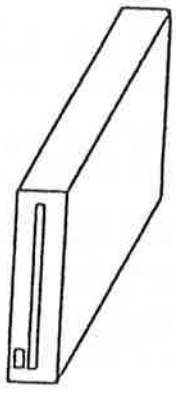
It is recommended that the following connector parts be provided by the user.

Connector	3M P/N 3463-0001
Polarity Key	3M P/N 3439-0000
Flat cable	3M P/N 3365/34

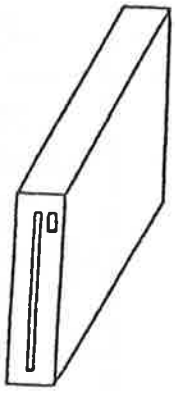
4.5 Installation



Horizontal installation (the PCB side must be up)

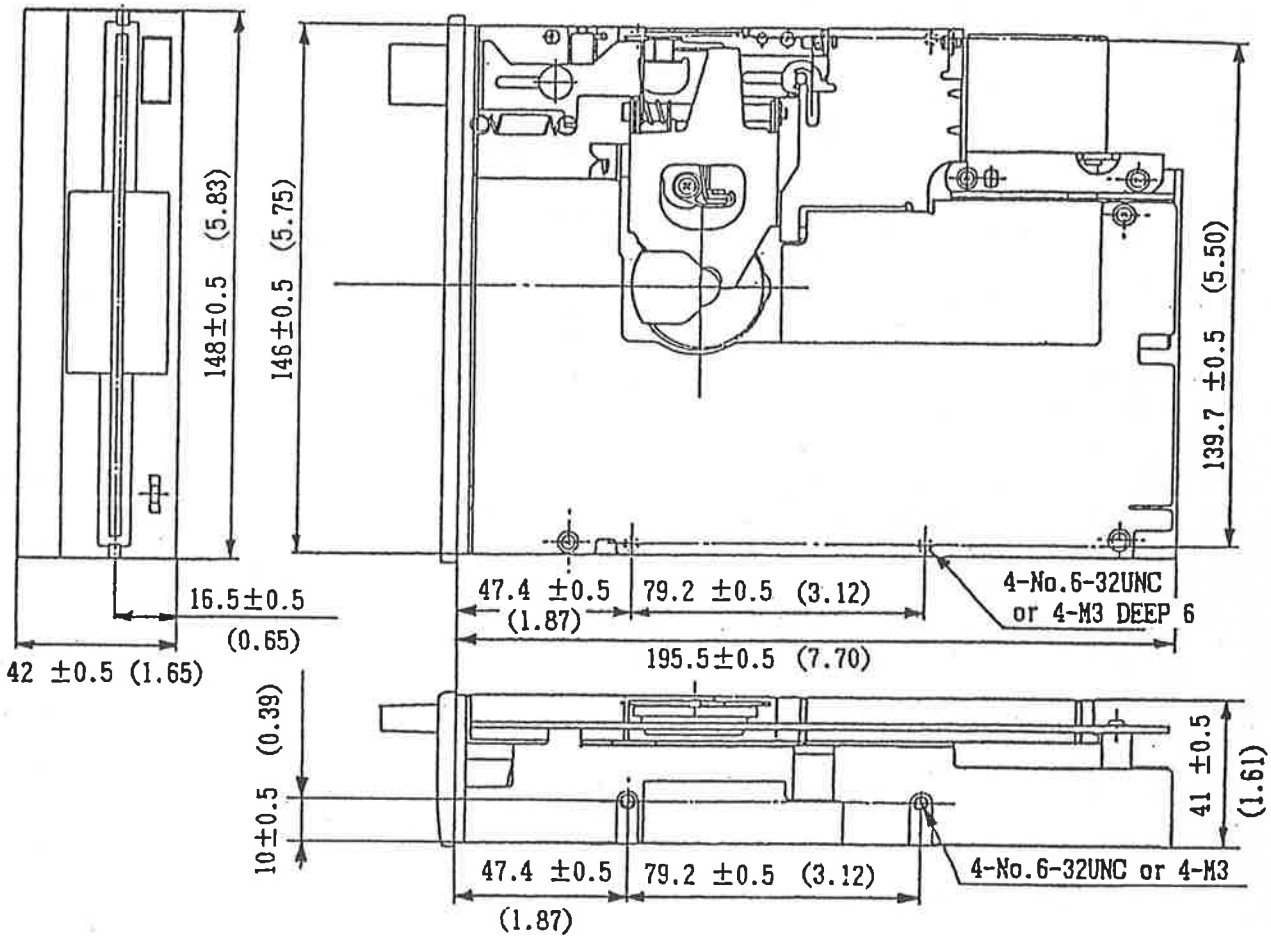


Button-side down installation



Button-side up installation

4. 6 Physical dimension



dimension:mm (inch)

SD-560

NOTES

NOVEMBER, 1983
REVISION #1

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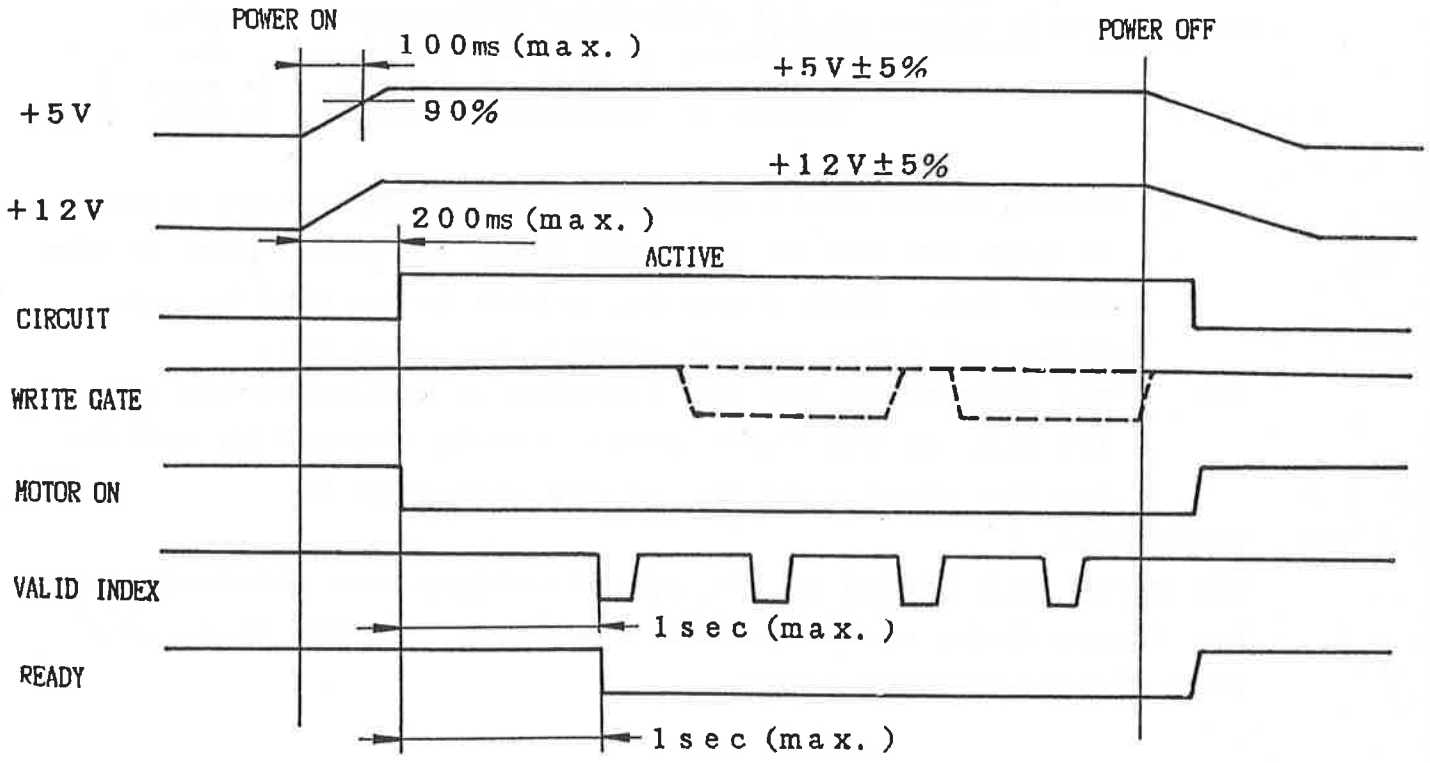
(1) Power Supply

(a) Power supplies of +12V and +5V are necessary. It makes no difference which of these power supplies is switched on or off first.

(b) Since an initial reset is performed in the FDD's internal circuitry after power is turned on, the rise time of the +5V power supply must be less than 1ØØ msec.
The FDD is equipped with a safeguard feature which makes sure that information stored on the floppy disks are not destroyed due to transient current present in the head when power is turned on or off. However, it is necessary to maintain the I/F signal's WRITE GATE signal at "H" level.
The illustration below shows the sequence performed when power is turned on or off.

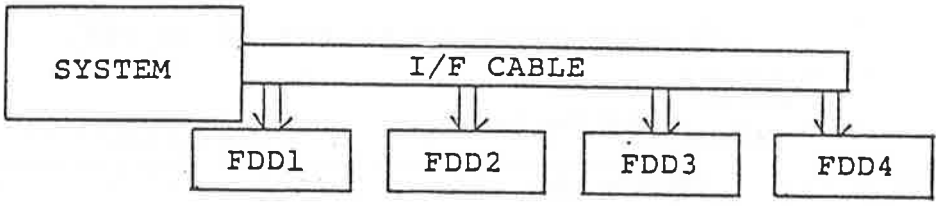


(c) The maximum current of the FDD is:
1.5A (max) for the +12V system
Ø.72A(max) for the +5V system

(2) Interface

(a) Daisy Chain

A maximum of 4 FDDs can be connected to form a daisy chain. At the time of delivery from factory, all FDDs are supplied with a 15Ø ohm terminal resistor inserted into the IC socket on the control PCB. This resistor can be inserted or removed by the user. Please remove all terminal resistors from the FDDs connected in a daisy chain (except for the FDD furthest away on the I/F cable) seen from the system.
Example: 4 FDDs connected: Remove resistors from FDD 1-3. Leave FDD 4 as it is. In the case of 3 FDDs, remove the resistors from drives 1 and 2, leaving 3 as it is.



During daisy chain operation, the drive select signal of each FDD can be selected using the short plug on the FDDs' PCB. When doing so, please be careful to use different drive select signals for each FDD.

(b) The conditions for the lighting up and going out of the LED, on the front panel, can be changed by switching the short plug on the PCB (see page 9).

(3) Error Rate

The error rate listed on the specifications was obtained using floppy disks of the recommended type. Please be careful when choosing floppy disks.

(4) Head Cleaning

During normal use, the heads seldom need cleaning. If R/W errors occur during use, use a cleaning diskette (commercially available), rotating the media for about 30 seconds and performing SEEK while loading the head.

(5) Inserting Floppy Disks

In order to protect your floppy disks, don't use force when inserting them into the FDD and don't apply too much pressure to the pushbuttons.

(6) Caution

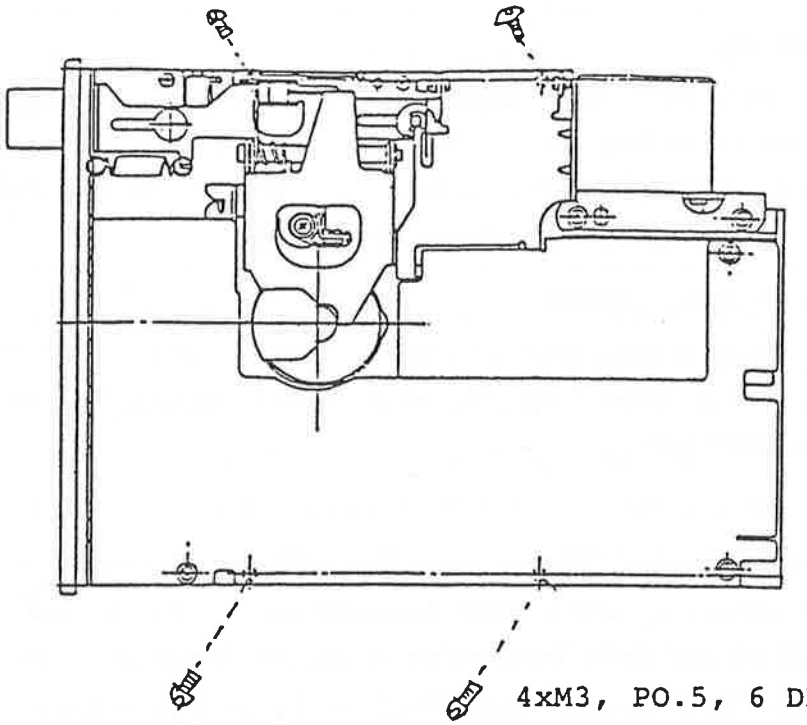
Measures have been taken against external noise from CRTs, etc., interfacing with FDD operation. Please note, however, when installing this FDD with a whole system, the error rate may deteriorate during Read/Write if noise sources such as CRTs, etc., are not shielded off completely.

(7) Type of Floppy Disks Used

This FDD uses only high density diskettes such as Maxell Md2-HD or similar products. Ordinary floppy disks cannot be used.

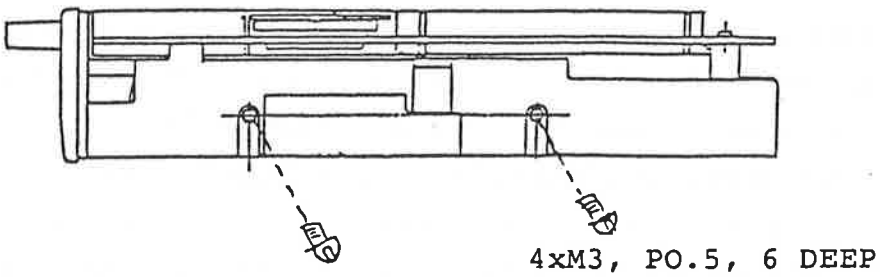
(8) Installation of Drive (Tightening torque: 4.0kg·cm)

(Top View)



Note: This illustration shows the FDD viewed from the main board. The actual holes for the screws are on the other side of the main board.

(Side View)



Note: The number of screw holes and their position is the same on both sides.

(9) NOTICE OF INSTALLATION

The tolerance of the distance between the screw holes is ±Ø.5 mm. Please note the position of the holes and their diameter on the part being installed (see illustration of the exterior for measurements).

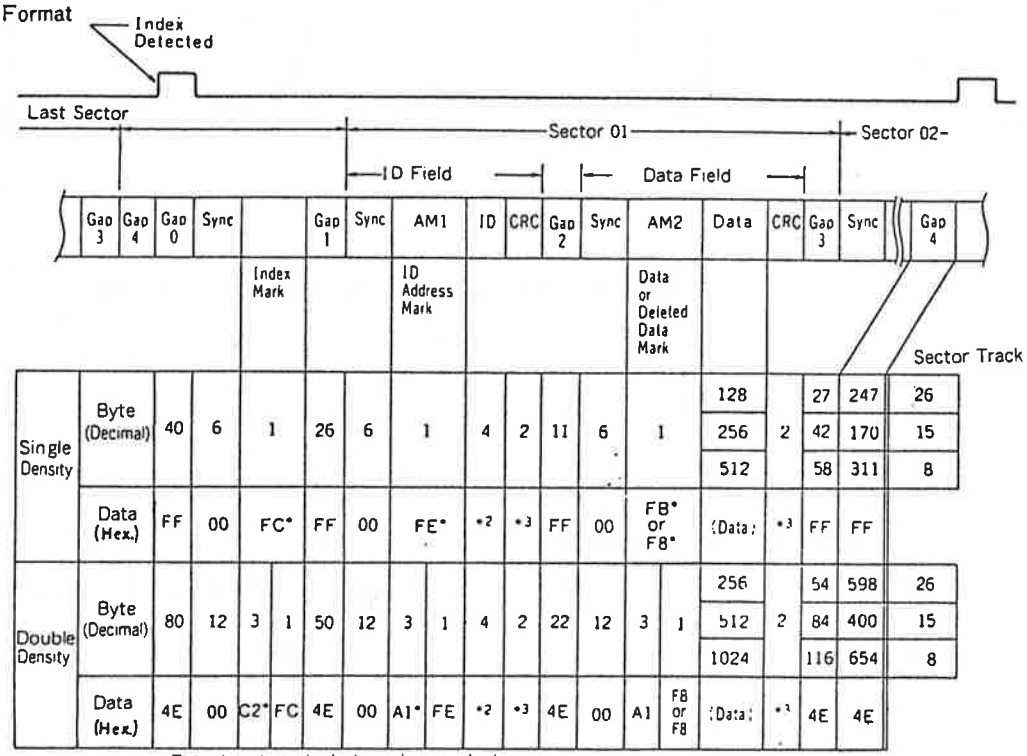
(10) Heat Generation

Please use a set up which takes ventilation, radiation, etc., into consideration so that the temperature of the FDD and the floppy disks never exceeds the maximum temperature listed in the specifications.

(11) Format

The IBM format is recommended.

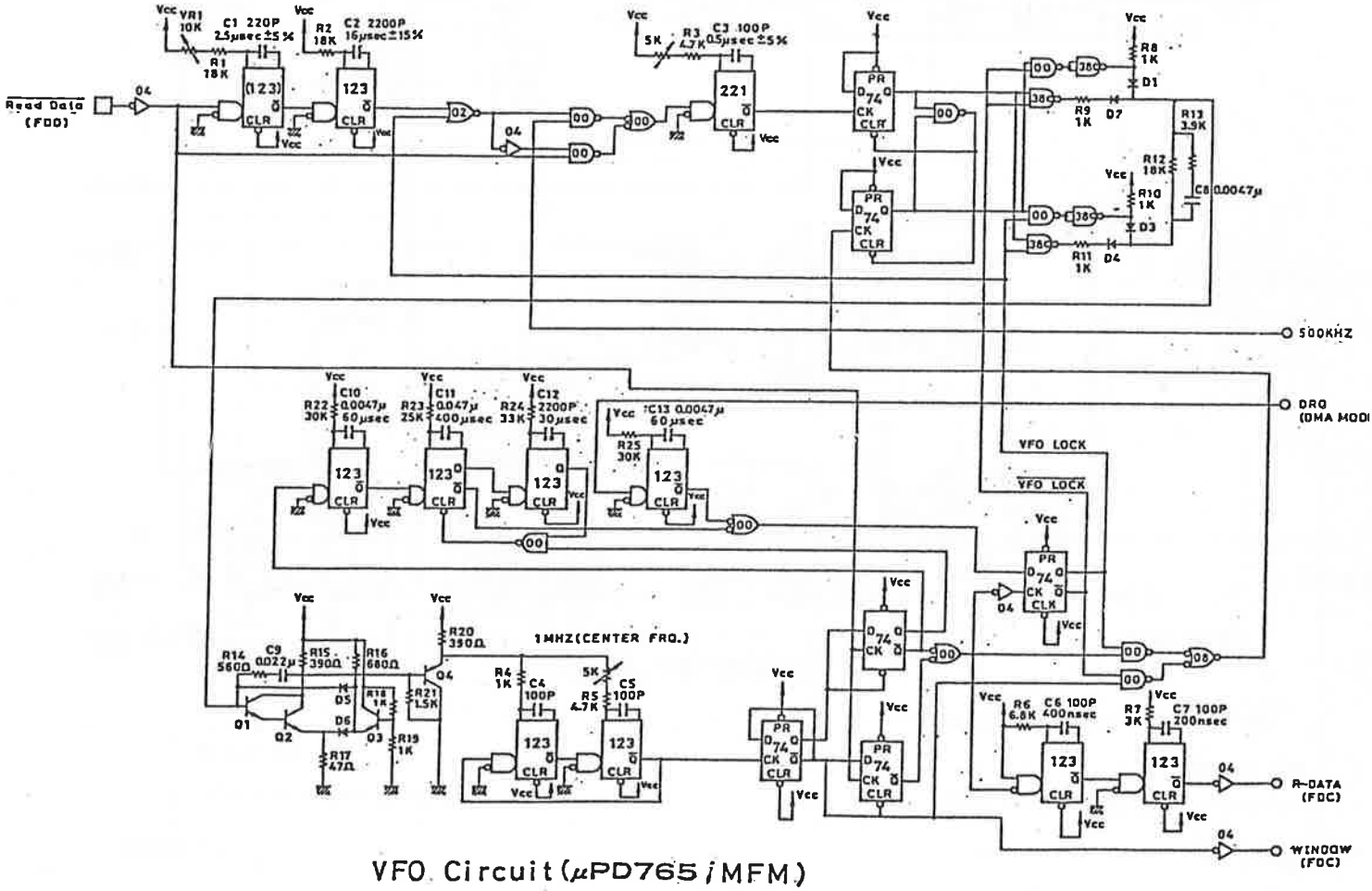
8 — 1 IBM Track Format



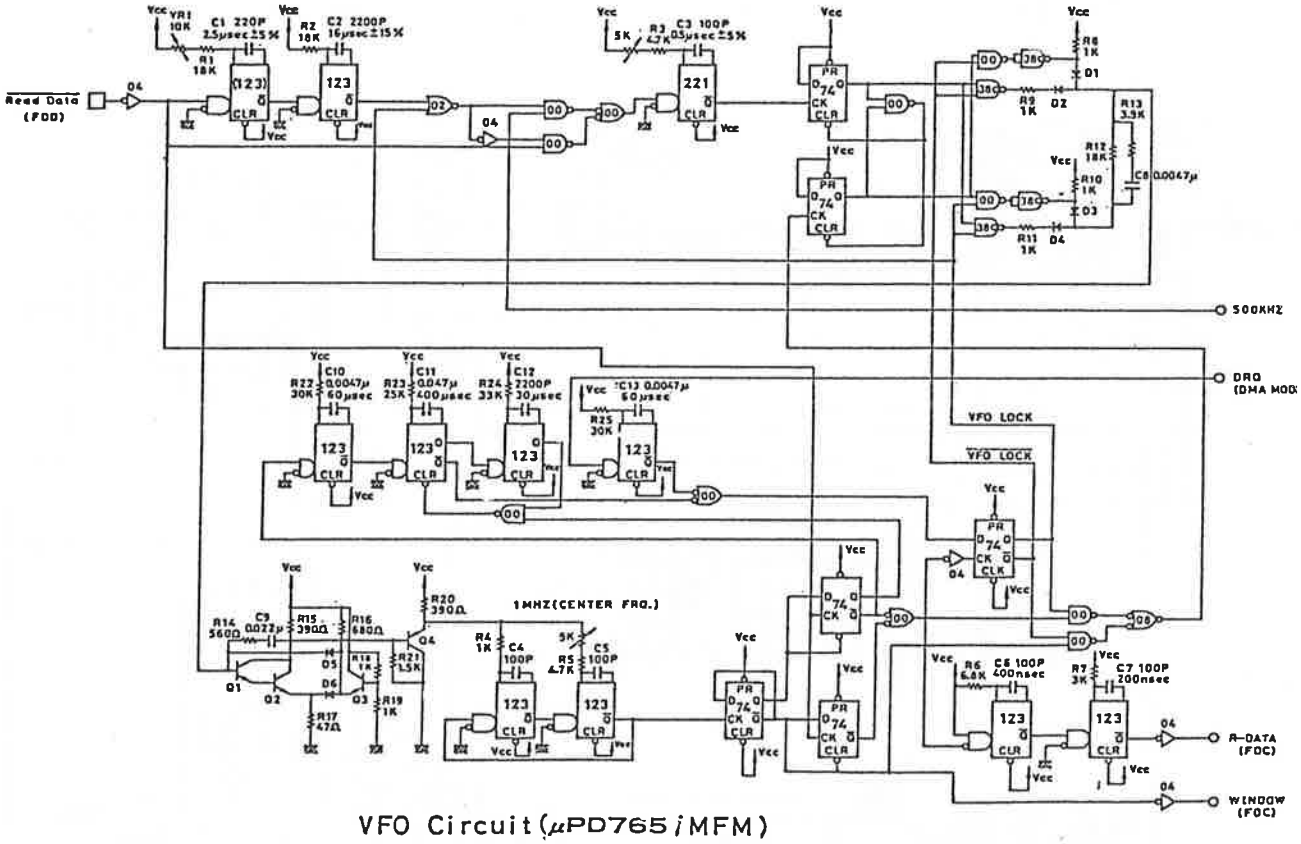
		Gap 3	Gap 4	Gap 0	Sync	Index Mark	Gap 1	Sync	AM1	ID	CRC	Gap 2	Sync	AM2	Data	CRC	Gap 3	Sync	Gap 4	Sector Track
Single Density	Byte (Decimal)	40	6	1	26	6	1	4	2	11	6	1			128	2	27	247	26	
															256		42	170	15	
															512		58	311	8	
	Data (Hex.)	FF	00	FC*	FF	00	FE*	*2	*3	FF	00	FB* or F8*			(Data)	*3	FF	FF		
Double Density	Byte (Decimal)	80	12	3	1	50	12	3	1	4	2	22	12	3	1	256	2	54	598	26	
																512		84	400	15	
																1024		116	654	8	
	Data (Hex.)	4E	00	C2*	FC	4E	00	A1*	FE	*2	*3	4E	00	A1	F8 or F8	(Data)	*3	4E	4E		

* This data byte includes missing clock.
*2 ID field
*3 CRC check byte $G(X) = 1 + X^5 + X^{12} + X^{16}$

(12) VFO

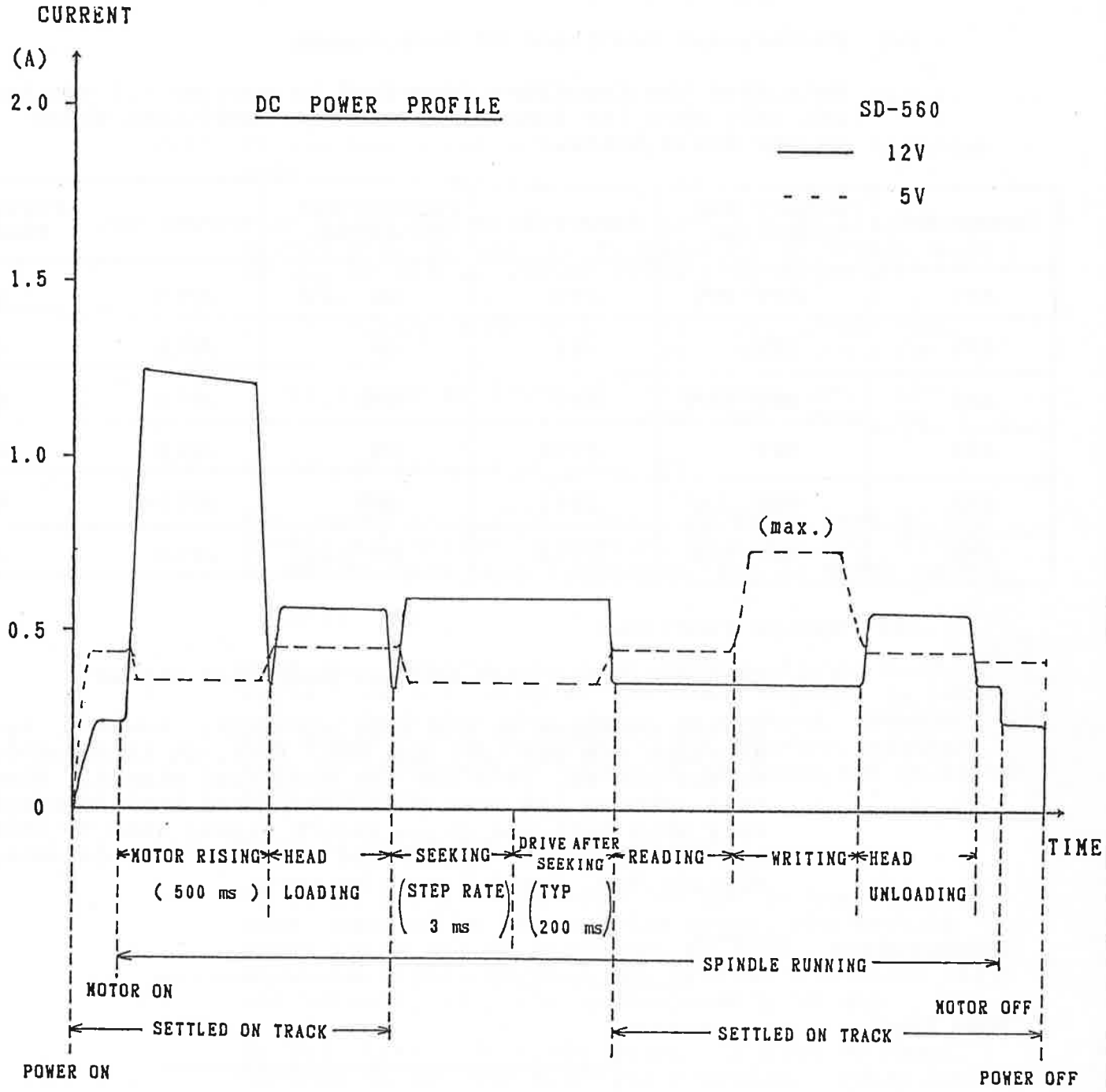


VFO Circuit (μPD765 / MFM)



VFO Circuit (μPD765/MFM)

(13) Power Consumption



(14) Jumper Selection Options

In addition to the options described in section 4.3.3 of the SD-560 specification, it is possible to add and change the functions of the disk drive as described below by cutting and shorting the pattern on the main PCB. In the descriptions that follow, ON refers to a connection that has been shorted and OFF to an open connection.

(a) Factory-Set Condition of Each Jumper

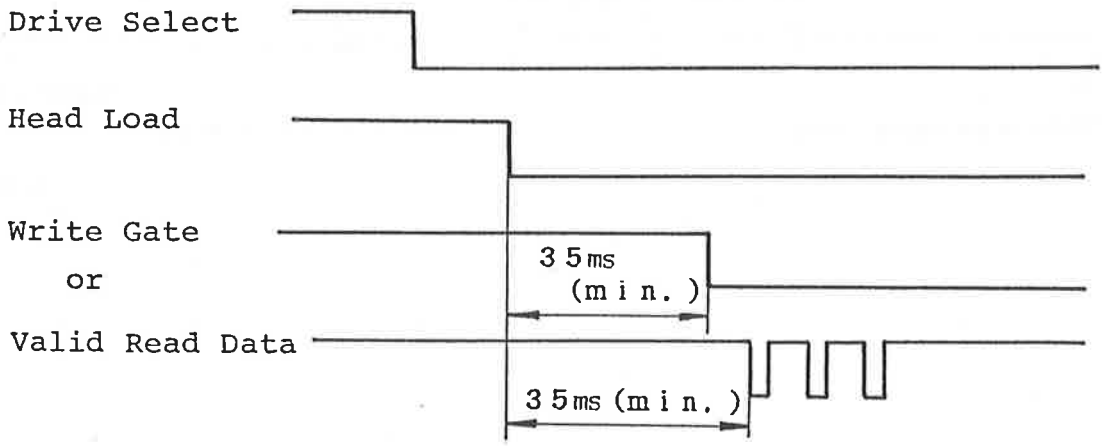
Note that the functions described in section 4.3 can be set only when the jumpers are in the conditions shown in the table below.

Jumper No.	Factory-Set Condition	Jumper No.	Factory-Set Condition	Jumper No.	Factory-Set Condition
JP1	~~OFF~~ ON	JP7	~~ON~~ OFF	JP13	OFF
JP2	OFF	JP8	ON	JP14	ON
JP3	~~OFF~~ ON	JP9	OFF	JP15	~~ON~~ OFF
JP4	OFF	JP10	ON	JP16	~~ON~~ OFF
JP5	~~OFF~~ ON	JP11	OFF	JP17	~~OFF~~ ON
JP6	~~ON~~ OFF	JP12	~~ON~~ OFF	JP18	OFF

(b) Option Functions

(i) To use pin No. J2-2 for the head load signal

SD-560 conforms to the ANSI standard. However, by shorting pin Nos. JP1 and JP17 (ON), it is possible to use pin No. J2-2 for the head load signal. When this setting has been performed, head load is possible only when both the drive select signal (DS0 to DS3) and the head load signal are active. In this case, SS2 pin Nos. 4 and 5 must be open.



(ii) To use pin No. J2-4 for the head load signal

The head load signal can be assigned to pin No. J2-4 by performing the following setting:

JP18: ON

NOTE: The timing is the same as for (i) above.

(iii) To use the drive select signal to select the disk side

When using the SD-560 in a system with single-sided floppy disk drives, it is possible to access side 1 of the SD-560 as either drive 1 or drive 3

To access as drive 1: JP3: ON, JP6: OFF,
JP4: OFF, JP5: ON

To access as drive 3: JP3: OFF, JP6: OFF,
JP4: ON, JP5: ON

(iv) To cancel restore at power ON

When power is applied, the read/write head of the SD-560 automatically returns to track 00. If you do not require this functions, set as shown below.

JP7: OFF

When this setting has been performed, the read/write head will stop at the track closest to its current position when power is applied. However, as the drive has an internal track counter, restore must be performed at power ON to reset the value of this counter.

(v) Spindle motor OFF delay setting

To avoid delay in access time due to the start up time required by the spindle motor, the setting shown below can be performed so that even when the motor ON signal becomes not active, the motor will not actually stop for approximately 30 sec.

At this time, the ready signal is used to check whether or not the motor is rotating. (This check, however, is performed only when a disk has been set in the drive.)

JP9: ON

(vi) To turn the index signal OFF when the ready signal is not active

As the factory-set condition, the index signal of the SD-560 remains active if a drive in which no disk has been set is selected.

In systems where the index signal is sensed by its level, this can give rise to problems. Therefore, perform the setting shown below to assure that the index signal will remain not active at all times except when the ready signal is active.

JP11: ON

JP12: OFF

(vii) To change the rise time of the ready signal

In the SD-560, the motor start up time is 1 sec. However, as stable rotation speed is reached in approximately 0.5 sec., the ready signal normally becomes active 0.7 to 0.9 sec. after the motor ON signal becomes active.

By performing the setting shown below, it is possible to have the ready signal become active 1 to 1.5 sec. after the motor ON signal becomes active.

JP10: OFF

(viii) To use pin No. J2-2 for return of the Drive Select signal

SD-560 conforms to ANSI 5" system; however, it is possible to use pin No. J2-2 for the DISK 2 SENSE (signal for double sided) used in 8" system.

By shorting pin No. JP2 (ON), pin No. J2-2 is active under the drive selected status.

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